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DOI: https://doi.org/10.1037/pspp0000165

Some Evidence for the Usefulness of an Optimal Foraging Theory Perspective on Goal Conflict and Goal Facilitation

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Author Note

This research was supported by the Swiss National Science Foundation Grant No. 10014-138045 "Readiness to Disengage from Motivational Conflict: Adult Age Differences and Implications for Emotional Experiences" (PI: Alexandra M. Freund) and benefited from the support of the Swiss National Centre of Competence in Research "LIVES – Overcoming Vulnerability: Life Course Perspectives," which financially supported the first and second author as post docs. We are grateful to Michaela Riediger who, together with Alexandra M. Freund and Paul B. Baltes, conducted Study 2 at the Max Planck Institute for Human Development in Berlin and to Nicholas Moberly from the University of Exeter for providing us with his data set on intergoal relations for Study 3. Correspondence concerning this research should be addressed to Martin J. Tomasik, Institute for Educational Evaluation, Wilfriedstrasse 15, 8032 Zurich, Switzerland. Email: tomasik@psychologie.uzh.ch

Abstract

Based on optimal foraging theory, we propose a metric that allows evaluating the goodness of goal systems, i.e., systems comprising multiple goals with facilitative and conflicting interrelations. This optimal foraging theory takes into account expectancy and value, as well as opportunity costs, of foraging. Applying this approach to goal systems provides a single index of goodness of a goal system for goal striving. Three quasi-experimental studies ($N = 277$, $N = 145$, and $N = 210$) provide evidence for the usefulness of this approach for goal systems comprising between three to 10 goals. Results indicate that persons with a more optimized goal-system are more conscientious and open to new experience, are more likely to represent their goals in terms of means (i.e., adopt a process focus), and are more satisfied and engaged with their goals. Persons with a suboptimal goal system tend to switch their goals more often and thereby optimize their goal system. We discuss limitations as well as possible future directions of this approach.

Keywords: Disengagement; goal systems; multiple goals; optimal foraging.

Some Evidence for an Optimal Foraging Theory Perspective on Goal Conflict and Goal Facilitation

Goals, defined as "desired states that people seek to obtain, maintain or avoid" (Emmons, 1996, p. 314), can be considered as "building blocks of personality and development in adulthood" (Freund & Riediger, 2006, p. 353) that provide direction and meaning to a person's life (Freund, 2007; Klinger, 1977; Little, 1989). Goals guide attention and behavior (e.g., Bargh & Ferguson, 2000) and represent a standard for evaluating performance (e.g., Bandura, 1989), which in turn affects subjective well-being (e.g., Brunstein, 1993). Given the importance of goals for adaptation and development, it is not surprising that there are numerous theories that attempt to explain and understand the processes of goal setting (e.g., Austin & Bobko, 1985; Locke & Latham, 1990), goal striving (e.g., Freund & Baltes, 2002; Gollwitzer & Brandstätter, 1997) and goal adjustment (e.g., Brandtstädter & Rothermund, 2002; Wrosch, Scheier, Carver, & Schulz, 2003). Most of these theories focus on single, isolated goals and their characteristics, while others explicitly take into account that goals are organized in goal systems (e.g., Kruglanski et al., 2002). The latter approaches recognize that, in everyday life, most people strive for multiple goals that are often interconnected (e.g., Dodge, Asher, & Parkhurst, 1989) and can have complex positive (or facilitative) and negative (or interfering) reciprocal relationships, both at the level of means and outcomes of goal striving (Riediger & Freund, 2004; Sheldon & Kasser, 1995). These approaches increasingly gain scientific attention (e.g., Tomasik, 2016).

Compared to the wealth of knowledge about characteristics of single goals, only very little is known about the adaptiveness of the goal *system* of a person for goal pursuit and achievement. The purpose of this paper is to propose a metric that allows evaluating the goodness of goal systems comprising multiple goals. We develop our argumentation in six steps:

First, we review the central concepts and findings of expectancy-value theories for single goals in order to present one possible definition of what makes a goal a "good goal." Second, we expand this position to multiple goals, review some literature on positive and negative intergoal relations, and again ask what makes a goal system a "good goal system." Third, we combine the former and the latter to arrive at an expectancy-value model taking into account intergoal relations. Fourth, we derive a mathematical formalization of intergoal relations based on the theory of optimal foraging – a framework successfully applied in behavioral biology to predict how animals behave when they search for food – in order to combine the expectancy-value approach with what we know about intergoal relations. This mathematical formalization allows computing a metric for evaluating the goodness of goal systems, which we do in the fifth step using empirical data from three quasi-experimental studies. Finally, we discuss the empirical findings obtained and point to future directions towards a theory of multiple goals.

On Expectancies and Values: What Makes a "Good Goal?"

What constitutes adaptive goal selection and goal setting, in particular with regard to subsequent goal achievement? Bandura (1997) argued that specific, proximal, and moderately challenging goals promote self-efficacy and are related to higher performance. Other researches have argued that specific goals that are difficult to achieve are associated with highest performance, at least as long as ability is not at its limits (Locke & Latham, 1990). However, performance is not only limited by ability. Researchers who take a developmental perspective argue that it is necessary to consider the changing opportunities and constraints for goal attainment across the lifespan (Freund & Baltes, 2002) as a blueprint against which the adaptive value of goals can be defined. Similarly, Heckhausen (1999) argued that, in order to make an optimal use of individual and social resources, people should take into account the age-sequential

opportunity structures provided by both biology and society when selecting goals. Within this lifespan theoretical framework, goals that are ambitious, but at the same time attainable relative to the biological, psychological, and social resources available to the individual, are considered as conducive to subjective well-being (Sheldon & Elliot, 1999) and successful development (Brandtstädter & Rothermund, 2002; Freund & Baltes, 2002).

Taken together, the different theoretical perspectives converge in the notion that, in adaptive goal setting, people need to balance (a) relatively high standards or aspirations with (b) relatively high attainment probability of a goal given the available resources and opportunity structures. This notion is closely related to motivational expectancy-value models (for reviews see Eccles & Wigfield, 2002; Wigfield & Eccles, 2000). Expectancy-value models assume, that behavior is best explained by the multiplicative product of attainment probability (or *goal expectancy*) and the valance of a goal (or *goal value*). People do not necessarily choose the alternative that is most attractive or most likely attainable, but the alternative that maximizes the *product* of expectancy and value, thereby optimizing the emotional reward after success and information about one‘s ability after failure (H. Heckhausen, Schmalt, & Schneider, 1985). In line with this theoretical framework, we define the goodness of goals as the combination of a high subjective incentive (or value) with a high goal attainment probability (or expectancy) relative to available resources and opportunities.

On Intergoal Relations: What Makes a “Good Goal System?”

In their everyday lives, people usually strive for multiple goals (e.g., Dodge et al., 1989), such as goals in the domains of career, relationship, family, or health and well-being (Nurmi, 1992). The relationship between goals can be characterized by independence, facilitation, or interference (Argyle, Furnham, & Graham, 1981; Little, 1989). Whereas independent goals have

no relevant impact on each other, *intergoal facilitation* occurs when "the pursuit of one goal simultaneously increases the likelihood of success in reaching another goal" (Riediger, 2007, p. 121). This might result either from instrumental relations among goals or from overlapping goal attainment strategies (Riediger, 2007; Wilensky, 1983). An example of the former is the goal of obtaining an educational degree, which is likely instrumental in the goal of finding a good job. An instance of overlapping goal attainment strategies is that joining a sports club is effective for both improving one's fitness and getting to know new people. *Intergoal interference* or goal conflict occurs when "the pursuit of one goal impairs the likelihood of success in reaching the other goal" (Riediger, 2007, p. 122). Interference might result either form resource constraints, such as time or money, or from incompatible goal attainment strategies, such as wanting to lose weight and going on a gourmet vacation (e.g., Greenhaus & Beutell, 1985). Note that both facilitation and interference predominantly exist at the level of goal attainment strategies and goal-relevant resources, and relate to a much lesser degree to the compatibility or incompatibility of goal outcomes.

Empirical evidence suggests that intergoal facilitation and intergoal conflict are not opposite ends of one dimension, but can be considered as two independent goal dimensions (Riediger & Freund, 2004; Riediger, Freund, & Baltes, 2005): Some aspects of a goal might facilitate some and interfere with other aspects of another goal. For example, the goal of joining a sports club might be facilitative for the goal of having a large social network as one gets to know new people. However, the time spent in the sports club is not available for socializing with old friends whom one might eventually lose.

Their differential associations with other goal-related variables also support distinguishing intergoal facilitation and intergoal conflict as two independent dimensions: Goals

characterized by high facilitation are also pursued more intensively, as indicated by both self-reported goal involvement and objective behavioral measures (e.g., Riediger & Freund, 2006; Riediger et al., 2005). Intergoal facilitation, however, shows only weak, if any, associations with subjective well-being. In contrast, goal conflict is associated with lower subjective well-being, as indicated by measures of psychological distress, life satisfaction, psychosomatic complaints, as well as state and trait measures of emotional well-being (e.g., Freund, Knecht, & Wiese, 2014; Palys & Little, 1983; Pomaki, Maes, & ter Doest, 2004; Riediger & Freund, 2004). The associations of goal conflict with goal engagement, however, are weak and inconsistent.

The empirical evidence on intergoal relations cited thus far suggests that a goal system comprising multiple goals can be classified as a "good goal system" if it is characterized by many and strong facilitative relations between goals, as well as few and weak interfering relations. Such a goal system is not only likely to promote goal-related variables, such as engagement and persistence, but is probably also associated with higher subjective well-being and lower psychological distress.

Only little is known about the individual and contextual level predictors of "good goal systems." However, there is some evidence that older adults experience less goal conflict (e.g., Kehr, 2003; Locke, Smith, Erez, Chah, & Schaffer, 1994) and more goal facilitation (e.g., Riediger et al., 2005; Riediger & Freund, 2006) compared to younger adults. Why this is the case is not yet fully understood (but see Riediger & Freund, 2008; Tomasik & Freund, 2015). However, having an adaptive goal system seems to be one of the developmental phenomena that exhibit a positive trajectory across adulthood (Riediger, 2007).

Integrating Intergoal Relation within an Expectancy-Value Framework

Up to this point, we have argued that "good goals" are characterized by high expectancy

and value, and that "good goal systems" show high intergoal facilitation and low conflict. Combining these two propositions for a single goal means that a "good goal" should not only have a high product of expectancy and value but also, at the same time, have facilitative relations to (many) other goals which, in turn, also have a high product of expectancy and value. Furthermore, a "good goal" should have few interfering relations with other goals. If at all, it should interfere with goals that have low expectancy-value products. In other words, "good goals" are goals that are facilitated by, but do not conflict with, other "good goals." Extending this definition to goal systems, a "good goal system" is a system of multiple goals that have high expectancy-value products, strong facilitative relations with other high expectancy-value goals, and do not conflict with other goals or only with those with a low expectancy-value product. This conceptual proposition can be formalized based on the theory of optimal foraging often used in ethology. We derive this formalization in the next section.

A Mathematical Formalization of Intergoal Relations Based on Optimal Foraging

The starting point of the mathematical formalization of the goodness of a goal system is based on research in the area of foraging in animals (see also Segerstrom & Solberg Nes, 2006). We use a basic definition by Stephens and Krebs (1986, Chapter 2) that specifies the relationship of factors influencing the average rate of energy intake when foraging. The authors distinguish between T_s, defined as the time spent searching for a food source, and T_h, defined as the time spent handling the food. These two times then sum up to $T_s + T_h = T_f$, which is the entire time spent on foraging. If E_f is the net amount of energy gained in T_f, then the resulting rate R that an animal has to maximize is

$$R = \frac{E_f}{T_s + T_h}. \qquad (1)$$

Equation 1 simply states that the resulting rate R increases with the amount of energy

intake and decreases with the time needed to search and handle the food. In the following, we propose to rewrite this basic equation in order to make it compatible with an expectancy-value-approach (see also Charnov & Orians, 1973). To do this, we need to introduce the concept of encounter with food and assume that these encounters are linearly related to T_s so that we can express both E_f and T_h as linear functions of T_s. If λ is the rate of encounters with food items per time unit, then λT_s is the total number of items encountered. In addition, we need to introduce s as the cost of search per unit time, so that sT_s is the total cost of search. When $\bar{e}$ is the average energy gained per encounter and $\bar{h}$ is the average time spent handling, then $E_f = \lambda T_s \bar{e}$ and $T_h = \lambda T_s \bar{h}$. We can now substitute these relationships into Equation 1, so that the rate of energy intake becomes

$$R = \frac{\lambda T_s \bar{e} - sT_s}{T_s + \lambda T_s \bar{h}}. \qquad (2)$$

If T_s is canceled out, we arrive at the so-called disc equation originally proposed by Holling (1959)

$$R = \frac{\lambda \bar{e} - s}{1 + \lambda \bar{h}}. \qquad (3)$$

In Holling's disc equation, the resulting rate of energy intake becomes a function of the expectancy of encounter with food items (λ), the average caloric value of the food ($\bar{e}$), the opportunity costs of time spent searching (s), and the opportunity costs of time spent handling ($\bar{h}$). Note that in this equation the time spent searching (T_s) is no longer relevant.

The disc equation lays the foundation for more complex optimal foraging models that can, in principle, consider additional factors, such as uncertainty, information processing, varying danger over time when foraging, possibilities for energy storage, and many more (for a recent overview, see Stephens, Brown, & Ydenberg, 2007). It is empirically well supported for

animals foraging in patches, as well as for animals searching for prey. It has also been successfully applied as a basic model in the cognitive sciences (e.g., Hills, Jones, & Todd, 2012), marketing research (e.g., Wells, 2012), and research on personality (e.g., Segerstrom & Solberg Nes, 2006). For instance, Hills et al. (2012) investigated memory search paths by modeling between-patch and within-patch search strategies known from optimal foraging. Wells (2012) investigated consumer decisions and applied optimal foraging theory to conceptualize brand and product choice, retail choice, temporal issues, as well as social issues in consumer decisions. Between-patch and within-patch models are applied to understand, for instance, when a consumer is likely to switch between different brands.

Segerstrom and Solberg Nes (2006) applied foraging theory to study opportunity costs arising from goal conflict, which makes their paper particularly relevant for the present purpose. The authors investigated the role of dispositional optimism – i.e., generalized positive outcome expectancies – for the experience of goal conflict and subjective well-being. They computed a foraging function taking into account goal value and opportunity costs and argued that dispositional optimism increases this foraging function, which implies that optimists are efficiently balancing the benefits (i.e., goal value) and costs (i.e., opportunity costs) of their goals. In Study 1, they showed that dispositional optimism is cross-sectionally associated with conflict due to resource constraints but not with conflict due to incompatible goal attainment strategies. Hence, optimists tolerate (or even provoke) goal conflicts, presumably because they believe that their resources will somehow suffice to manage all conflicting goals. They are, however, not more likely to engage in goals that pull their resource in opposite directions. This finding is a first indication that optimists have optimized their goal system by increasing goal value (in striving for many, sometimes conflict goals) and decreasing opportunity costs (in

striving for coherent goals only). In a second, longitudinal study, the authors calculated the nominator of the disc equation as a foraging function for good goal pursuit strategy. Results showed that optimism was indeed significantly related to higher values of this function and that higher values of the foraging function were in turn related to higher subjective well-being and better goal progress. The foraging function thus proved useful for describing the psychological link between personality and psychological outcomes.

Based on the findings by Segerstrom and Solberg Nes (2006), we see at least two reasons for applying the disc equation to research on goal systems. First, the definition of a resulting rate *R* offers an interesting conceptualization for the goodness of a system of multiple goals. If we equate the attainment of single goals with the encounter of single items of food, we arrive at a straightforward definition of an optimal goal system similar to the definition of an optimal foraging strategy. Based on this definition, people should strive for goals that maximize the resulting rate by maximizing the product of "expectancy of encounter" and "caloric value," and minimizing opportunity costs of "searching" and "handling."

Second, the factors influencing the resulting rate *R* in optimal foraging can easily be translated into concepts that have long been successfully applied in motivational psychology. Hence, the expectancy to encounter forage λ can be considered the attainment probability of a goal within the expectance-value-framework. Similarly, the caloric value of the food $\bar{e}$ resembles the incentive value of a goal, and hence its importance. The net search costs *s* represent opportunity costs that, within a multiple goals framework, translate into costs that derive from conflicts between goals and are alleviated by intergoal facilitation.

Finally, the time spent handling $\bar{h}$ represents resources that are invested or costs that arise *after* a goal has been attained. Note that resources invested during goal striving are already

captured by the search costs *s* in the disc equation. The handling costs parameter $\bar{h}$, in contrast, is weighted by the expectancy of attainment probability parameter λ, and thus only becomes relevant after a goal has been attained. There are good theoretical reasons for setting this parameter to zero in the context of human goal striving. By definition, as has already been noted by James (1890), goals can be considered as end states that do not require further investment of resources once they are attained (for an overview, see Austin & Vancouver, 1996). The same seems to hold when a goal is abandoned (maybe due to low subjective probably of attainment or because circumstances have changed so that it is no longer desirable). Clearly, if a goal is no longer active (either because it has been attained or because it was abandoned), it does not incur any handling costs. Of course, new goals may arise after attaining a goal or might replace an abandoned goal. However, these are new goals, and the costs of their pursuits do not represent handling costs of the old goals. For these reasons, we set this parameter to zero, which simplifies the numerator of the disc equation to unity. Note, that the resources invested *during* goal striving are considered in the search costs part of the equation.

Accepting these assumptions, we can now translate the disc equation for optimal foraging into a disc equation for multiple goals striving. For any single goal *i*, the core of this equation is

$$R_i = \lambda_i e_i, \qquad (4)$$

where R_i represents the resulting rate of a goal. As in the original disc equation, the resulting rate is a function of the expectancy λ_i of a goal and its value e_i. This definition is compatible with the core of traditional expectancy-value-models in motivational psychology. Within a multiple goal framework, the opportunity cost *s* is a function of intergoal relations, namely, conflicts and facilitations with other goals $j = 1 \ldots (n\text{-}1)$ that originate from goal *i*. In defining the opportunity costs, we take into account both the strength of conflict and facilitation with another goal *j* and

this goal's expectancy-value product. For conflicting goal relations, we therefore subtract from Equation 4 the sum of the products of conflict strength originating from goal *i*, and affecting goal *j* (i.e., C_{ij}) and expectancy-value of the conflicting goal *j* (i.e., $\lambda_j e_j$) for all goals $j = 1\ldots(n\text{-}1)$ so that

$$R_i = \lambda_i e_i - \sum_{j=1}^{n-1} C_{ij} \lambda_j e_j \,. \qquad (5)$$

In Equation 5, the resulting rate R_i of a goal thus proportionally decreases if this goal stands in stronger conflict with many goals that have a higher expectancy-value product. If the conflicts originating from goal *i* are not very strong or the expectancy-value product of the conflicting goals *j* is low, then the resulting rate is less affected. We can do the same for facilitative relations between goals, and add to Equation 5 the sum of the products of facilitation strength originating from goal *i* and affecting goal *j* (i.e., F_{ij}) and expectancy-value product of the goal *j* that is facilitated (i.e., $\lambda_j e_j$) for all goals $j = 1\ldots(n\text{-}1)$ so that

$$R_i = \lambda_i e_i - \sum_{j=1}^{n-1} C_{ij} \lambda_j e_j + \sum_{j=1}^{n-1} F_{ij} \lambda_j e_j \,. \qquad (6)$$

Equation 6 describes the resulting rate of a single goal *i* as a function of its own expectancy-value, as well as the conflicting and facilitative relations it has with other goals $j = 1\ldots(n\text{-}1)$ weighted by these goals' expectancy-value product. We can do this for every goal $i = 1\ldots n$ in the goal system so that the resulting rate *R* of a goal system is

$$R = \sum_{i=1}^{n} R_i \,. \qquad (7)$$

From Equation 7, one can see that the resulting rate of a goal system *R* is higher the more single goals in this goal system have high individual resulting rates. Taken together, the resulting rate of a goal system can be maximized by having many goals with high expectancy-value

products that do not conflict with each other, but instead have strong facilitative associations. These intergoal associations of conflict and facilitation are weighted by the expectancy-value products of the other goals.

This framework raises two questions. The first question concerns the adequate operationalization of the single components in Equation 6; the second question concerns the adequate metrics of these components. Concerning operationalization, it would be possible, to some extent, to use objective indicators of expectancy, value, conflict, and facilitation. However, it seems more meaningful from a psychological perspective to use subjective appraisals, because these appraisals constitute people's psychological reality that is more relevant to predict individual behavior than objective indicators. This notion, sometimes referred to as the Thomas theorem, has also found empirical support in the goal literature (e.g., Mangos & Steele-Johnson, 2010). Expectancy λ, then, can be operationalized as the subjective estimation of goal attainment probability, value *e* can be operationalized as the subjective value of a goal or goal importance, and conflict *C* as well as facilitation *F* can be operationalized as subjective estimations of the conflict resp. facilitation potential that originates from a goal. All of these subjective operationalizations have been successfully used in previous research (e.g., Eccles & Wigfield, 2002; Riediger & Freund, 2008).

Concerning adequate metrics, two groups of variables in Equation 6 need to be distinguished. For expectancy λ and value *e*, any metric, such as a rating scale ranging from 0 to 7 or percentages ranging from 0% to 100%, can be used, as the choice of the metric does not change the meaning of *R*, but only affects the scale at which it is represented. In the following, we will use a scale ranging from 0 to 1 to represent λ and *e*. For conflict *C* and facilitation *F*, however, the choice of the metric is not trivial, as it directly influences the weighting of the other

goals in determining the opportunity costs from intergoal conflict and opportunity benefits from intergoal facilitation. Using nominally larger metrics gives conflict and facilitation a greater weight, and using nominally smaller metrics marginalizes the effect of these variables. Here, more theoretical work and/or empirical investigation is needed, and we can only speculate that the choice of the adequate metric depends on factors, such as the temporal scope of the goals investigated or their level of abstractness. In the following, we use a metric ranging from 0 to 1 to represent *C* and *F*. The choice of this metric basically assumes that the expectancy-value product of one goal can cancel out the expectancy-value product of another goal if the two goals are extremely conflicting ($C = 1$; e.g., taking one week off and working one week very hard); or that the expectancy-value product of one goal fully adds to the expectancy-value of another goal if the two goals perfectly facilitate each other ($F = 1$; e.g., finding a job and earning money). Note that in reality most *C*s and *F*s will be somewhere in-between 0 and 1.

Empirical Usefulness of the Goodness Index: Research Questions

The purpose of this paper is not only to attempt an integration of intergoal relations within an expectancy-value framework and to provide its mathematical formalization, but also to offer some empirical evidence about the usefulness of the concept. In order to do so, we have formulated predictions about the antecedents, the correlates, and the consequences of a "good goal system" as defined above. In the following, we will give an overview of these predictions, starting with variables directly related to the goal and concluding with variables related to the person.

Goal-Related Constructs

Having a "good goal system" should be associated with a more optimized investment of goal-related resources and positively predict goal-related constructs, such as *progress of goal*

attainment or *proximity of a goal*, both at the objective and at the subjectively perceived level. This should hold for both single goals in the goal system and the goal system as a whole. Thus, we hypothesized that a higher resulting rate *R* is positively correlated with these variables.

Goal Focus

When pursuing goals, people may either adopt an *outcome focus* by attending more to the goal's end (or *why* they want to reach a goal); or they may adopt a *process focus* by attending more to the goal-relevant means (or *how* they want to reach it; Freund & Hennecke, 2015). At the first glance, the concept of goal focus might resemble related concepts such as extrinsic/intrinsic motivation (e.g., Deci, Koestner, & Ryan, 1999) and performance/mastery orientation (e.g., Dweck & Leggett, 1998). However, there are also clear distinctions (for a detailed discussion, see Freund, Hennecke, & Mustafić, 2012). For instance, although intrinsic motivation entails a focus on the process and extrinsic motivation on the consequences of attaining a certain outcome, the opposite is not true. Both process and outcome focus can be either extrinsically or intrinsically motivated. Freund et al. (2012) argue that adopting a process focus as opposed to an outcome focus is beneficial for goal engagement in the long run, because it offers opportunities for positive rewards by the very pursuit of a goal.

Indeed, outcome and process focus have been shown to be differentially associated with other goal-related variables, goal pursuit, and affective well-being, with process focus showing more positive effects (e.g., Freund, Riediger, & Hennecke, &, 2010). We, too, hypothesize that adopting a process focus is beneficial for a high resulting rate *R*, because people who focus on the means while pursuing goals should be more sensitive to the facilitative and interfering relations between goals that, as outlined above, usually exist at the level of strategies and goal-relevant resources. This higher sensitivity, in turn, should result in an optimization of the means

so that more facilitation and less interference occur. If this is the case, a higher *R* could explain why process focus is associated with more goal engagement and persistence during goal striving.

Goal Disengagement

If goals are highly unlikely or impossible to attain, goal disengagement is usually associated with positive adjustment and development, as it helps people to save resources that would otherwise be wasted into unpromising goal striving, to avoid repeated experiences of failure, and allow to redirect resources into goals that are more likely attainable (Tomasik & Salmela-Aro, 2012; Tomasik & Silbereisen, 2012; Tomasik, Silbereisen, & Heckhausen, 2010; Wrosch et al., 2003). In the present paper, we relate the resulting rate *R* both as an antecedent and as a consequence of goal disengagement. First, we hypothesize that persons with a goal system of a low resulting rate *R* are more likely to disengage from one or more goals compared to persons with a higher resulting rate *R*. In other words, we expect that a lower resulting rate *R* is one of the driving forces that instigate goal disengagement, presumably because these goals do not fit well into the goal system. Second, we hypothesized that, after disengagement, the resulting rate *R* of a goal system increases. Although re-engaging with a new goal does not necessarily result in a more adaptive goal system in every single case, at least on average this should be the case if intergoal relations and available resources are optimized over time.

Personality Constructs

Numerous studies have investigated the relation between personality (broadly defined) and goals or goal systems that people hold (e.g., Roberts & Robins, 2000), providing evidence that personality is related to different aspects of goals (including their domain and specific content) and goal-related behavior (including goal engagement and persistence in goal striving). From the perspective of the Big Five concept of personality (e.g., John & Srivastava, 1999),

three constructs stand out that are likely associated with a "good goal system." If one considers that people who can select from a broader variety of existing goals are probably more likely to arrive at a more adaptive selection, *openness to experience* should be associated with a higher resulting rate *R*. Second, the adaptive organization of a goal system requires some amount of discipline, which is a central aspect of *conscientiousness*. Furthermore, it requires being steadfast against impulsiveness and irritability, which is the opposite of *neuroticism*. Research by Emmons and King (1998) has demonstrated that neuroticism is also correlated with more goal conflict. In contrast, extraversion and agreeableness are probably less relevant for goal striving. We therefore hypothesized that openness to experience and conscientiousness are positively related to the resulting rate *R* of a goal system, whereas the relation with neuroticism is negative.

Subjective Well-Being

People who have goal systems that are characterized by a high resulting rate *R* should also be more successful in progressing towards, and eventually attaining, their goals. If this is true, a high resulting rate *R* should be positively associated with variables indicating successful development in terms of subjective well-being, such as *satisfaction with life* or *positive affect*.

Chronological Age

Goal systems seem to become more facilitative and less conflicting with advancing age (Riediger, 2007). This fact may either represent a manifestation of the increasing structural integration of different aspects of life and personality with increasing age (see Erikson, 1959), but may also be a reflection of the increasingly negative dynamics of developmental gains and losses, which requires a selective optimization of the aging individual's diminishing resources by focusing on those goals that support each other and selecting out those that conflict with other goals (Riediger & Freund, 2006). Regardless of the processes underlying the association of age

with a less conflicting and more facilitative goal system, we hypothesized that age is positively correlated with the resulting rate *R* of a goal system.

Overview of the Present Studies

We tested this hypothesis using correlative data from three studies. Study 1 is a correlative self-report study with working adults with family, and who thus need to negotiate goals in the domains of work, family, and leisure. Study 2 is a study on adults starting to exercise and, in addition to self-report, comprises data on exercising directly obtained from the sports facilities. Study 3, finally, is a self-report study sampling undergraduate students and obtained data on as many as 10 goals from each participant. The data sets of these studies were used in previous publications but our research questions and corresponding analyses substantially differ from those in the previous publications.[1] Correlations of all variables analyzed are available as an online supplement to this paper.

Study 1 conformed to and was approved by the ethics committee of the Psychology Department at the University of Zurich. The protocol of Study 2 was in line with the ethics guidelines of the Max Planck Society and was approved by the Institute's ethics committee. Study 3 was reviewed and approved by the University of Exeter Psychology Department's ethics committee that scrutinizes research in accordance with the British Psychological Society ethical code of conduct.

Study 1

Sample and Procedure

Data of Study 1 comes from a three-wave longitudinal study on multiple goals with a time lag of six months between the measurements conducted in Switzerland (for a description of the study at T1 and participation criteria see Freund, Knecht, & Wiese, 2014, for a description of

all three waves see Knecht, Wiese, & Freund, 2016). The initial sample at T1 comprised $N = 277$ employed young and middle-aged adults, 57% of them were women. Mean age of the participants was $M = 41.76$ years ($SD = 7.19$ years). Regarding education, 34.3% held a university degree, and 15.9 % had graduated from an applied college. Almost 70% of the participants had at least one child. The sample attrition over time was fairly low with $n = 253$ (91%) at T2 and $n = 248$ (90%) at T3 staying in the study. $N = 237$ (86%) provided data at all three measurement occasions.

At the first measurement point, participants were asked to name six of their current personal goals, two each in the life domains of work, family, and leisure. At the follow-ups, participants had to indicate whether they were still pursuing all of these goals. If not, they had to replace the abandoned goal with a new one within the same life domain. Goals that were not meaningful or did not represent goals according to our definition were removed, resulting in an effective sample size of $n = 269$ (T1), $n = 237$ (T2), and $n = 233$ (T3). Complete data on all three measurement occasions were provided by $N = 218$ participants.

Measures

Variables for calculating the goodness of a goal system. For each of the six goals, participants were asked to indicate on six-point scales (ranging from 0 to 5) the *importance* of the respective goal ("How important is this goal to you?" with responses anchored at "not at all important" and "extremely important"; Freund & Knecht, 2015) and goal *attainment probability* ("How certain are you to realize/to successfully pursue the goal?" with responses anchored at "very uncertain" and "very certain"). Furthermore, using a procedure introduced by Riediger and Freund (2004), participants were asked to indicate for each pair of goals how much one goal stood in conflict with the other one ("How much do the two goals hinder each other? [Goal A]

hinders [goal B]:" with responses anchored at "not at all" and "very strongly") and how much one goal facilitated the other one ("How much do the two goals facilitate each other? [Goal A] facilitates [goal B]:" with responses anchored at "not at all" and "very strongly"). Note that, for the assessment of goal conflict and goal facilitation, each goal pair was rated twice, where a goal either was the source or the target of conflict or facilitation, resp. Altogether, there were 30 ratings of goal conflict and 30 ratings of goal facilitation at each measurement occasion (Knecht & Freund, 2015). Goal conflict and goal facilitation were correlated moderately negatively within domains (T1: $-.31 < r < -.27$; T2: $-.43 < r < -.29$; T3: $-.39 < r < -.23$) and virtually uncorrelated across domains (T1: $-.10 < r < .00$; T2: $-.12 < r < .06$; T1: $-.06 < r < .02$), and hence were not redundant. Correlation coefficients for the same pair of goals were quite substantial for the two reciprocal measures of conflict (T1: $.47 < r < .76$; T2: $.50 < r < .80$; T3: $.55 < r < .78$), as well as for the two reciprocal measures of facilitation (T1: $.45 < r < .81$; T2: $.54 < r < .80$; T1: $.57 < r < .81$). Thus, there is substantial overlap of conflict and facilitation in both directions (i.e., if engaging in sports conflicts with spending time with children, spending time with children is also likely to hinder engaging in sports).

For each goal *i* of each participant, we computed the resulting rate R_i according to Equation (6). Based on this, for each participant's goal system, we computed the resulting rate *R* according to Equation (7).[2] Using $C = [0..1]$, $F = [0..1]$, and all other variables in their original metric in Equation 6, the mean of the resulting rate *R* for the overall goal system comprising six goals was $M = 6.91$ ($SD = 6.27$; range from -6.73 to 36.00) for T1, $M = 6.64$ ($SD = 6.51$; range from -6.92 to 36.00) for T2, and $M = 6.96$ ($SD = 6.04$; range from –8.84 to 33.60) for T3.

Goal-related constructs. For each of the six goals, participants were asked to indicate on six-points scales (ranging from 0 to 5): (1) *progress made* towards the goals in the last two or

three weeks ("Have you come closer to your goal?" with responses anchored at "not at all" and "very much"), (2) *satisfaction with goal progress* ("How satisfied are your right now with regard to your goal and goal progress?" with responses anchored at "not at all satisfied" and "extremely satisfied"), (3) *perceived proximity* to goal attainment ("How close are you in your opinion to the attainment of your goal?" with responses anchored at "very far away" to "attained"), as well as (4) *prospective engagement* in the next six months ("In the following six months: How much do you expect to do for your goal?" with responses anchored at "nothing" and "extremely much"). For each of these four constructs, we averaged the responses across the six goals. The measures were assessed at all three measurement occasions (progress T1: M = 2.31, SD = .92; T2: M = 2.81, SD = .87; T3: M = 2.94, SD = .85; satisfaction with goal progress T1: M = 2.49, SD = .88; T2: M = 2.83, SD = .88; T3: M = 2.95, SD = .85; perceived proximity T1: M = 2.40, SD = .77; T2: M = 2.81; SD = .77; T3: M = 2.92, SD = .81; prospective engagement T1: M = 3.55, SD = .67; T2: M = 3.45, SD = .70; T3: M = 3.50, SD = .72).

Goal focus. For each of the six goals, participants were asked to indicate on six-point scales (ranging from 0 to 5) how much they focused on the means of goal pursuit (process focus; "When pursuing your goal, how much are you guided by the motto: 'The journey is the destination'?" with responses anchored at "not at all" and "much") and on the outcome of goal pursuit (outcome focus; "When pursuing your goals, how much are your guided by the motto: 'The most important thing is that I achieve my goal – how I do so does not play a big role'?" with responses anchored at "not at all" and "much"). This measure has previously been used successfully in different studies (see Freund & Hennecke, 2015). Responses were averaged across the six goals to arrive at an overall measure of process and outcome focus. The measures were assessed at all three measurement occasions (process focus T1: M = 3.13, SD = 1.23; T2: M

= 3.19, *SD* = 1.13; T3: *M* = 3.26, *SD* = 1.17; outcome focus T1: *M* = 2.68, *SD* = 1.27; T2: *M* = 2.43, *SD* = 1.27; T3: *M* = 2.61, *SD* = 1.34).

Goal disengagement. At T2 and T3, participants were presented the six goals that they had listed at T1 and asked whether they still pursued each of them. Between T1 and T2, 59.3% of the participants confirmed that this was the case, whereas 23.3% no longer pursued one of their six goals, 10.7% no longer pursued two of their six goals, and the remaining 6.7% no longer pursued three or more of their six goals. Between T2 and T3, respectively, the numbers were very similar to 59.3% of all participants who retained all six goals, 22.2% who dropped one goal, 11.3% who dropped two goals, and 7.2% who dropped three or more goals. If a goal was no longer up to date, participants were asked to nominate a new goal in the respective life domain and assessed all goal-related information with regard to this new nomination.

For the following analyses, we computed a new grouping variable for each of the six goals indicating whether the respective goal had remained stable throughout the course of the study or whether participants changed it at least once. Based on this operationalization, 23.7% of the participants changed the primary work goal, 25.2% the secondary work goal, 16.8%, the primary family goal, 14.5% the secondary family goal, 17.9% the primary leisure goal, and 19.8% the secondary leisure goal.

Personality constructs. As reported in Freund et al. (2014), this study used the German short version of the Big Five inventory by Rammstedt and John (2005). Internal consistencies at T1 and one-year stabilities between T1 and T3 were $\alpha = .75$ and $r_{tt} = .81$ for neuroticism, $\alpha = .84$ and $r_{tt} = .77$ for extraversion, $\alpha = .71$ and $r_{tt} = .77$ for openness to new experience, $\alpha = .61$ and $r_{tt} = .74$ for agreeableness, and $\alpha = .66$ and $r_{tt} = .71$ for conscientiousness.

Indicators of subjective well-being. A German version of the Satisfaction with Life

Scale by Diener, Emmons, Larsen and Griffin (1985) was used to assess general satisfaction with life (for details, see Knecht et al., 2016). The internal consistency of this scale at T1 was $\alpha = .86$, and the one-year stability between T1 and T3 was $r_{tt} = .74$. The short version of the multidimensional mood questionnaire by Steyer, Schwenkmezger, Notz and Eid (1997) assessed positive affect. This questionnaire comprises the subscales "bad-good," "tired-awake," and "uneasy-calm," which were collapsed to one single scale for positive affect. The internal consistency of this scale at T1 was $\alpha = .91$, and the one-year stability between T1 and T3 was $r_{tt} = .65$.

Chronological age. Age was assessed by self-report and ranged from 30 to 55 years.

Results

Goal-related constructs. To test the hypothesis that a higher resulting rate of a goal system is associated with more favorable appraisals on the goal-related constructs, we first computed zero-order correlations at all three measurement occasions. A higher resulting rate was positively correlated with perceived progress (T1: $r = .27$, $p < .001$; T2: $r = .30$, $p < .001$; T3: $r = .37$, $p < .001$), satisfaction with goal progress (T1: $r = .26$, $p < .001$; T2: $r = .31$, $p < .001$; T3: $r = .32$, $p < .001$), perceived proximity of goal attainment (T1: $r = .32$, $p < .001$; T2: $r = .31$, $p < .001$; T3: $r = .35$, $p < .001$), and prospective engagement (T1: $r = .47$, $p < .001$; T2: $r = .46$, $p < .001$; T3: $r = .44$, $p < .001$).

In order to test the direction of these effects over time, we set up cross-lagged panel models for the three waves of data. For each goal-related construct, a separate model was set up. Both the resulting rate *R* and the goal-related construct were modeled as latent variables with three indicators each, one for each domain of life. Measurement invariance across time was tested and established, and also the respective structural paths were fixed to be equal across time,

which did not negatively affect the model fit.

Results of the cross-lagged panel models are summarized in Table 1. Overall, all four models fit the data very well, and all four showed a consistent picture with the resulting rate *R* at measurement point *t* predicting residual change in the goal-related construct at measurement point *t + 1*. More specifically, a higher resulting rate *R* predicted an increase in perceived progress (T1: β = .22, $p < .001$; T2: β = .26, $p < .001$), satisfaction with goal progress (T1: β = .12, $p = .04$; T2: β = .14, $p = .04$), perceived proximity of goal attainment (T1: β = .17, $p = .01$; T2: β = .16, $p = .01$), and prospective engagement (T1: β = .25, $p = .04$; T2: β = .26, $p = .05$). Hence, a more optimized goal system was beneficial for negotiating one's goals. It is worth noting that prospective engagement was the only goal-related construct that was associated with the resulting rate *R* in the other causal direction (T1: β = .29, $p < .001$; T2: β = .34, $p < .001$). Thus, participants who intended to be more engaged in pursuing their goals in the future reported to have a more optimized goal system at the next measurement occasion. At the same time, those who had a more optimized goal system also engaged more.

Goal focus. To test the hypothesis that a higher resulting rate is associated with a higher process focus, but not with a higher outcome focus, we computed zero-order correlations. Again, a higher resulting rate was associated with a higher process focus (T1: $r = .41$, $p < .001$; T2: $r = .32$, $p < .001$; T3: $r = .35$, $p < .001$) but, with one exception, not with a higher outcome focus (T1: $r = .02$, $p = .78$; T2: $r = .14$, $p = .03$; T3: $r = .04$, $p = .51$).

Using cross-lagged panel analyses as described above, we found that a higher process focus only marginally significantly predicted residual change in the resulting rate between T1 and T2 (β = .08, $p = .09$) and between T2 and T3 β = .07, $p = .10$). Also, the coefficients in the other direction also were only marginally significant if tested two-tailed (T1: β = .09, $p = .07$;

T2: β = .10, p = .07). Despite the relatively high zero-order correlations between process focus and the resulting rate, our hypothesis thus was only marginally confirmed. Model fit and all model coefficients can be found in Table 1, which, for the sake of completeness, also includes the result for outcome focus.

Goal disengagement. For each of the six goals, we first tested whether the goal-specific resulting rate R_i at T1 was significantly smaller for participants who subsequently nominated a new goal. This was the case for the primary work goal, $t(253) = 2.62$, $p = .01$ and the primary leisure goal, $t(253) = 1.98$, $p = .05$, but not for any of the other four goals ($.11 < p < .84$). Hence, some goals that were more likely to be abandoned during the course of the study had a significantly lower goal-specific resulting rate R_i at the study's outset.

In a next step, we tested whether a goal shift was succeeded by an increase in the respective resulting rate R_i. For each of the six goals, we computed a repeated measures ANOVA with the goal-specific resulting rate R_i as the dependent variable at the three measurement occasions, time as the within-subject factor, and whether or not the respective goal was changed at least once as the between-subject factor. Using this analysis, we primarily tested for a time × goal change interaction term, indicating that R_i changed differently depending on whether or not a participant changed the goal. This was the case for the primary work goal, $F(2, 432) = 4.09$, $p = .02$, the primary family goal, $F(2, 432) = 4.35$, $p = .01$, and marginally for the primary leisure goal, $F(2, 432) = 2.43$, $p = .09$, but not for any of the secondary goals ($.26 < p < .70$). These results are depicted in Figure 1.

In sum, the hypothesis that goal shifts were preceded by a relatively lower goal-specific resulting rate R_i and resulted in its increase was confirmed for the primary, but not for the secondary, goals. A depiction of the goal-specific trajectories of the resulting rate R_i is presented

in Figure 1.

Personality constructs. To explore associations of the resulting rate *R* with personality, we computed zero-order correlations for each of the three measurement occasions. For T1, our hypotheses were confirmed. A higher resulting rate *R* was positively correlated with conscientiousness ($r = .17$; $p = .01$) and with openness to new experience ($r = .14$; $p = .02$), but not with any of the other three of the Big Five. At T2, a higher resulting rate was only correlated with openness to new experience ($r = .13$, $p < .04$), but not with any other of the personality constructs ($.07 < p < .19$). At T3, a higher resulting rate was, as expected, correlated with conscientiousness ($r = .14$; $p = .04$), openness to new experience ($r = .18$; $p = .01$), and neuroticism ($r = -.15$; $p = .02$). Unexpectedly, we also found significant correlations with extraversion ($r = .17$; $p = .01$) and agreeableness ($r = .18$; $p = .01$).

Using regression analyses to predict residual change in the resulting rate *R*, we found that only openness for experience predicted an increase in *R* between T1 and T2 ($\beta = .11$, $p = .03$). However, we could not replicate this finding between T2 and T3, and none of the other personality constructs significantly predicted change of the resulting rate *R* over time. Taken together, we have to conclude that, although our hypotheses with regard to personality were confirmed for T1, the associations were rather weak and not robust over time.

Indicators of subjective well-being. In order to test the hypothesis that a higher resulting rate R is associated with better subjective well-being, we computed for each measurement occasion zero-order correlations between the resulting rate *R*, on the one hand, and satisfaction with life as well as mood, on the other. Contrary to our hypotheses, none of these correlations ($-.04 < r < .12$) was significant ($.06 < p < .75$), with the only exception that positive affect was positively correlated with the resulting rate at T3 ($r = .15$, $p < .02$).

Chronological age. We found a small, but significant, correlation between the resulting rate *R* and chronological age at all three measurement occasions ($.16 < r < .17$; $.01 < p < .02$), which confirmed our hypothesis that older participants report more optimized goal systems.

Discussion

Study 1 provides evidence that the goodness of a goal system as indexed by a higher resulting rate *R* is correlated with higher perceived goal progress, satisfaction with the goal, perceived proximity of goal attainment, as well as prospective engagement. Also as expected, process focus, but not outcome focus, was associated with a higher resulting rate. Further support for the validity of the resulting rate as an index of the goodness of a goal system was obtained from the analyses on goal shifts. For most of the primary goals, a shift was predicted by a relatively low resulting rate at the previous measurement occasion, and entailed a higher resulting rate the next time it was measured. In other words, people changed goals that did not fit well with their goal system and switched to goals that were more adaptive in this regard.

Results relating to the association of resulting rate with personality factors, indicators of subjective well-being, and age were less promising. Although conscientiousness and openness to experience were positively correlated with a higher overall resulting rate, the effect sizes of these correlations were rather small. Moreover, subjective well-being was not correlated with the measure for the goodness of a goal system. Although there was some evidence for the expected association of age resulting rate, the effect size was quite small. Note, however, that different from other studies that found stronger relations between age and goal conflict, as well as facilitation across adulthood, the age range in the present sample was restricted to middle adulthood.

In sum, Study 1 provides initial empirical evidence for the usefulness of the foraging

theory approach for analyzing multiple goal systems. The strengths of this study are its longitudinal design, the ideographic assessment of personal goals and their intergoal relations at all measurement occasions, as well as the low attrition rate. Limitations are the exclusive reliance on self-reports concerning goal engagement and the restricted age range. These limitations were addressed in the subsequent study.

Study 2

While Study 1 relied exclusively on self-reports concerning goal engagement, Study 2 included, in addition to many of the measures used in Study 1, also an objective measure of goal engagement. Study 2, therefore, serves both as a replication and an extension of Study 1.

Sample and Procedure

Data of this study were assessed at the Max Planck Institute for Human Development in Berlin, Germany (see Riediger et al., 2005). Participants of this study were $n = 99$ younger (19 - 35 years) and $n = 46$ older (55 years and older) sports beginners who were recruited from sports facilities, such as fitness centers and sports clubs (see Riediger et al., 2005, for further details on the study). Most of the participants were female (74.5%), and the majority (59.3%) had graduated from *Gymnasium* (i.e., the highest school track in Germany). Participants filled out self-report questionnaires at the beginning of the study (T1) and then approximately four months later (T2). At T1, participants were asked to nominate three goals that were most important to them right now, in addition to the goal of starting exercise that all of them shared. At T1 and T2, participants provided subjective goal evaluations similar to those used in Study 1. In addition, where possible, objective attendance data based on attendance lists and electronic attendance registrations were attained by the sports facilities.

Measures

Variables for calculating the goodness of a goal system. For each of the four goals, participants were asked to rate on a seven-point scale (ranging from 1 to 7) the *importance* of the respective goals ("Please indicate […] how important each of the four goals is for you personally" with responses anchored at "very little important" and "extremely important"). Similarly, goal *attainment probability* was assessed with the question "How certain are you to realize/to successfully pursue that goal?" with responses anchored at "very uncertain" and "very certain."

Goal conflict at T1 was assessed for each pair of goals (again, in both directions) with three items related to resource limitations ("How often can it happen that because of [goal A] you do not invest as much time as you wanted in [goal B]?", "How often can it happen that because of [goal A] you do not bring up as much money for [goal B] as you wanted?", and "How often can it happen that because of [goal A] you do not invest as much power and energy in [goal B] as you wanted?"), and one item related to logical incompatibility ("How often can it happen that you do something with regard to [goal A] that is incompatible with [goal B]?" with all responses anchored at "never/very rarely" and "very often"). Five-point scales (ranging from 1 to 5) were used. For each pair of goals, the respective four items were averaged to indicate overall goal conflict. More information about this measure is provided in Riediger and Freund (2004).

Goal facilitation at T1 was assessed for each pair of goals with one item related to instrumental relationships ("Striving for [goal A] lays the foundations for realizing [goal B]?" with responses anchored at "does not at all apply" and "totally applies") and one item related to overlapping goal attainment strategies ("How often can it happen that you do something for [goal A] that at the same time is conducive to [goal B]?" with responses anchored at "never/very

rarely" and "very often"). Five-point scales (ranging from 1 to 5) were used. For each pair of goals, the respective two items were averaged to indicate overall goal facilitation (see Riediger & Freund, 2004). Conflict and facilitation for each goal pair were mostly uncorrelated or correlated negatively ($-.34 < r < .05$).

Based on the scores for goal importance, attainment probability, goal conflict, and goal facilitation, we computed the resulting rates in the same way as we did in Study 1. The mean of the resulting rate *R* for the overall goal system at T1 was $M = 4.03$ ($SD = 2.49$; range from .04 to 14.69). We could not compute the same measure for T2.

Goal-related constructs. *Subjective progress made* towards each of the four goals was assessed at T1 and T2 using a seven-point scale ("In the last three or four months/Since our last session four months ago, have you moved toward that goal or have you moved away from it?" with responses anchored at "moved very far away" and "moved very far toward that goal." By averaging all four responses, we obtained an indicator of goal progress across all four goals (T1: $M = 4.99$, $SD = .74$; T2: $M = 4.87$, $SD = .81$). At both T1 and T2, participants were also asked to indicate their *satisfaction with goal progress* ("How satisfied are your right now with regard to your intentions and your development?" with responses anchored at "very dissatisfied" and "very satisfied"). Again, averaging across the four goals yielded an overall scale (T1: $M = 4.71$, $SD = .83$; T2: $M = 4.69$, $SD = .86$). Perceived *proximity to goal attainment* was assessed using a seven-point scale at T1 ("How far in your opinion are you currently away from this goal?" with responses anchored at "very far away" and "very close") and using an eight-point scale at T2 (same item wording with responses anchored at "very far away" and "goal already attained"). Averaging across the four goals yielded an overall scale (T1: $M = 4.56$, $SD = .83$; T2: $M = 4.82$, $SD = .93$).

Prospective engagement for each goal was measured at T1 with a five-point scale ("How much are you engaged in realizing that intention?" with responses anchored at "very little" and "very much"). Again, averaging responses across the four goals yielded an overall scale (M = 3.94, SD = .61). Similarly, *retrospective engagement* was measured at T2. For all four goals, retrospective engagement was assessed using a seven-point scale ("How much did you engage in this goal in the last four month since our first interview?" with responses anchored at "very little" and "very much"). Averaging responses yielded an indicator for overall goal engagement (M = 4.72, SD = .85).

In addition to this general self-report on retrospective engagement for all goals, *frequency of exercising* was assessed for each month ("How often did you exercise in [calendar month]?" with responses anchored at "not at all" and "several times a week" using a four-point scale), *regularity of exercising* ("How regularly did you exercise each time in [calendar month]?" with responses anchored at "very irregularly" and "very regularly" on a five-point scale), and *length of average training session* ("On the average, how long did you exercise each time in [calendar month]?" with responses anchored at "less than half an hour" and "more than two-and-a-half hours" on a six-point scale). Frequency of exercising was recoded to represent actual days per month and averaged across all months (M = 5.80, SD = 3.79), exercise regularity was averaged across all months (M = 3.34, SD = 1.26), and so was average exercise duration (M = 2.81, SD = 1.09), which roughly corresponds to approximately 1.5 to 2 hours per exercise.

In addition to these specific self-reports, *objective information on exercise frequency* was available for 107 participants based on information provided by sports facilities. According to attendance lists and electronic attendance registration data, participants exercised on M = 2.62 (SD = 1.64) days per month on average. The self-report and objective measures were highly

correlated depending on whether participants exercised only at the sport facility ($r = .80$, $p < .001$) or also in other contexts ($r = .51$; $p < .001$).

Personality constructs. For assessing personality, the German translation of the NEO-FFI by Borkenau and Ostendorf (1993) was used, from which 30 items were randomly selected as described by Staudinger, Fleeson and Baltes (1999). Internal consistencies were $\alpha = .75$ for neuroticism, $\alpha = .50$ for extraversion, $\alpha = .38$ for openness to experience, $\alpha = .74$ for conscientiousness, and $\alpha = .53$ for agreeableness.

Indicators of subjective well-being. The Life Evaluation Scale by Ferring, Filipp, and Schmidt (1996) was used to address satisfaction with life in general. The internal consistency of this scale at T1 was $\alpha = .88$, and the four-months stability was $r_{tt} = .76$. In order to assess positive affect "in the last three to four months", again the short version of the multidimensional mood questionnaire by Steyer et al. (1997) was used. The internal consistency at T1 was $\alpha = .94$, and the four-months stability was $r_{tt} = .61$.

Chronological age. Age was assessed by self-report at T1.

Results

Goal-related constructs. A higher resulting rate at T1 was significantly correlated with subjective progress made ($r = .27$, $p < .001$), satisfaction with goal progress ($r = .34$, $p < .001$), prospective engagement ($r = .46$, $p < .001$), and perceived proximity to goal attainment ($r = .24$, $p < .01$).

Predicting residual change in all of these variables (except in prospective engagement), we found significant and quite strong regression coefficients for subjective progress made ($\beta = .30$, $p < .001$), satisfaction with goal progress ($\beta = .27$, $p < .01$), as well as proximity to goal attainment ($\beta = .24$, $p < .01$).

At T2, a higher resulting rate (measured at T1) was also significantly correlated with overall retrospective engagement ($r = .41$, $p < .001$), self-reported frequency of exercising ($r = .30$, $p < .01$), self-reported regularity of exercising ($r = .28$, $p < .01$), self-reported length of an average training session ($r = .23$, $p < .01$), as well as objective frequency of exercising ($r = .28$, $p < .01$) as reported by the sports facilities.

Personality constructs. Confirming our hypotheses, a higher resulting rate *R* was significantly correlated with conscientiousness ($r = .18$, $p = .03$) and neuroticism ($r = -.18$, $p = .04$). However, it was not correlated with openness to new experience ($r = -.10$, $p = .24$). We also found a significant correlation with agreeableness ($r = .19$, $p = .02$), but not with extraversion ($r = .03$, $p = .72$).

Indicators of subjective well-being. Different from Study 1, a higher resulting rate *R* was weakly, but significantly, correlated with life satisfaction ($r = .21$, $p = .01$) and with positive affect ($r = .22$, $p < .01$). Furthermore, a higher resulting rate significantly predicted change in positive affect over time ($\beta = .17$, $p = .01$), but not change in life satisfaction ($\beta = .01$, $p = .93$).

Chronological age. As predicted, age was positively correlated with a higher resulting rate and, with this more age-diverse sample, the effect size of the correlation was more substantial than in Study 1, $r = .39$ ($p < .001$). Note, however, that the correlation was, although positive, neither significant within the younger ($r = .13$, $p = .20$) nor within the older age group ($r = .19$, $p = .21$) when analyzed separately. This might either be due to the fairly small resulting sub-sample sizes or to the fact that the age-related differences are mostly between younger and older adults.

Discussion

Replicating results from Study 1, we found consistent associations between a higher

resulting rate *R* and subjective indicators of goal progress. In addition, we found two out of the three hypothesized correlations with personality variables. In addition to the subjective indicators, we also found evidence on an objective level based on data provided by the sports facilities. People who held a more optimized goal system thus did only report pursuing their goals in a more engaged way, but actually did so from an objective perspective.

Different from Study 1, there was also some support for the hypothesis that a higher resulting rate is associated with better subjective well-being. One of the reasons for this discrepancy between the two studies might be that, because all sports beginners shared a common and probably personally salient goal of starting to exercise regularly, successfully pursuing this goal might have been more relevant for subjective well-being compared to Study 1 in which a broad range of goals at very different levels of goal pursuit was nominated and investigated.

Also different from Study 1, we found evidence that older adults held more optimized goal systems. This might be due to the fact that Study 2 included a broader age range. Nevertheless, due to the cross-sectional design of the study regarding age effects, it is impossible to determine if associations with age represent developmental change or might reflect cohort differences.

Study 3

Participants in Studies 1 and 2 were asked to generate six or four personally important goals, respectively. One might argue that four to six goals are not sufficient to represent a person's entire goal system. Furthermore, when nominating the most important goals only, the variance on the importance variable is probably restricted. In Study 3, we therefore tested some of our hypotheses using a dataset comprising as many as 10 most important goals nominated by

the participants. Data of this study were retrieved from the UK Data Archive with permission of the principal investigator Nicholas Moberly, who conducted this study at the University of Exeter, UK.[3]

Sample and Procedure

Participants in this study were sampled by convenience from an undergraduate population at the University of Exeter. Overall, $N = 210$ mostly female (81%) subjects between 18 and 35 years of age ($M = 19.97$; $SD = 2.48$) took part in the first part of the study (T1) where they, among other things, were asked to generate 10 current goal strivings and rate them on different dimensions, including intergoal conflict and facilitation. In the second part of the study conducted one month later (T2), $n = 194$ participants returned to the laboratory and, again among other things not analyzed here, retrospectively rated each striving with regard to progress made and effort invested. More details on sampling and procedure are provided by Moberly and Dickson (2016).

Measures

Variables for calculating the goodness of a goal system. All participants were asked to list at least 10 personal strivings in different domains of life and then select 10 strivings that were personally most representative. These strivings were then rated by the participants using six-point scales (ranging from 0 to 5) on 16 different dimensions, including *importance* ("How important is this striving to your life [i.e., how committed are you to be successful in this striving]?") and *expectancy* ("In the next month, how successful do you think you will be in this striving)" with responses anchored at "not at all" and "extremely").

Goal facilitation ("Please rate the extent to which pursuing each of the strivings below makes it easier to pursue each of the strivings on the right.") and *goal conflict* ("Please rate the

extent to which pursuing each of the strivings below makes it more difficult to pursue each of the strivings on the right.") were assessed using a form similar to that used by Riediger and Freund (2004). Participants could rate intergoal facilitation and conflict using a six-point scale (ranging from 0 to 5) with responses anchored at "not at all" and "extremely"). Again, goal facilitation and conflict were rated in two directions for each goal pair, which resulted in 90 ratings of goal facilitation and 90 ratings of goal conflict. Based on all these data, we computed the resulting rate R_i for each goal according to Equation (6). Figure 2 depicts the means of the single goals' resulting rates and makes obvious that goals that are nominated first are not necessarily the ones with the highest resulting rate. The omnibus test for significant differences between the single goals was highly significant, $F(9, 1881) = 2.77$, $p < .01$. For the following analyses, we computed the overall resulting rates R based on Equation (7) using all 10 nominated goals. Using $C = [0..1]$, $F = [0..1]$, and all other variables in their original metric, the mean of the resulting rate R at T1 was $M = 17.73$ ($SD = 10.93$; range from -9.22 to 59.32). We could not compute the same measure for T2.

Goal-related constructs. *Subjective goal progress* was assessed retrospectively for each goal at T2 with a six-point scale (ranging from 0 to 5) using the item "Over the last month, how much progress have you made pursuing this striving?" with responses anchored at "none at all" and "extreme." Averaging this item across 10 goals resulted in an overall scale ($M = 5.37$; $SD = 1.18$). *Satisfaction with goal progress* was measured for each goal at T1 and T2 on a six-point scale using the item "Over the last month, how satisfied are you with the amount of progress made towards this striving?" with responses anchored at "very unsatisfied" and "very satisfied." Averaging the responses across all 10 goals resulted in an overall scale of satisfaction (T1: $M = 3.12$; $SD = .68$; T2: $M = 2.94$; $SD = .58$).

Engagement was measured for each goal at T1 generally and at T2 retrospectively. At both measurement occasions, six-point scales (ranging from 0 to 5) were used with responses anchored at "none at all" and "extreme." *General engagement* was assessed at T1 using the item "How much energy and effort do you generally expend in trying to be successful in this striving?" and averaging this item across all 10 goals resulted in an overall scale (M = 3.25; SD = .53). *Retrospective engagement* was assessed at T2 using the item "Over the last month, how much effort have you put into this striving?" and averaging this item across all 10 goals resulted in an overall scale (M = 2.79; SD = .71). General and retrospective engagement were correlated at r = .44 ($p < .001$)

Goal focus. At T1, participants were asked for each of the 10 goals on a six-point scale (ranging from 0 to 5) to indicate their awareness of *process focus* ("You may or may not have a well-formed idea or plan of how you will go about trying to be successful in your strivings. How clear an idea do you have of what is required of you in order to be successful in this striving?" with responses anchored at "not at all" and "extremely"). Although this item does not directly measure process focus, but rather its awareness, we argue that this awareness is a necessary condition to apply a process focus when pursuing at least moderately complex goals. We averaged the responses across the 10 goals to arrive at an overall measure (M = 3.42; SD = .65).

Personality constructs. The data set comprised a measure of neuroticism from the Eysenck Personality Questionnaire Short Form (Eysenck, Eysenck, & Barrett, 1985). The internal consistency of the scale was α = .72 at T1. No other measures of personality were available in the data set.

Indicators of subjective well-being. In Study 3, the Beck Depression Inventory-II (Beck, Steer, & Brown, 1996) was administered at T1 and T2 to assess depressive symptoms.

Internal consistency at T1 was $\alpha = .90$, and the test-retest stability was $r_{tt} = .63$ over the course of one month.

Chronological age. Age was assessed by self-report at T1. Participants' age ranged from 18 to 35 years with 95% of the sample being younger than 23 years.

Results

Goal-related constructs. A higher overall resulting rate *R* was positively correlated with subjective progress made at T2 ($r = .32$, $p < .001$), satisfaction with goal progress at T1 ($r = .46$, $p < .001$) and T2 ($r = .23$, $p < .01$), as well as general engagement at T1 ($r = .51$, $p < .001$) and retrospective engagement ($r = .38$, $p < .001$) at T2. In addition, a higher resulting rate significantly predicted residual change in goal engagement (retrospective engagement at T2 statistically controlling for general engagement at T1; $\beta = .22$, $p < .01$). However, residual change in satisfaction with goal progress could not be predicted by a higher resulting rate ($\beta = .02$, $p = .82$). Our hypotheses thus were largely confirmed.

Goal focus. Awareness of process focus was positively correlated with a higher resulting rate ($r = .36$, $p < .001$), which confirmed our hypotheses.

Personality constructs. Contrary to our hypotheses, but in line with results of Study 2, the resulting rate was weakly and only marginally significantly correlated with neuroticism ($r = -.12$, $p = .08$).

Indicators of subjective well-being. A higher resulting rate was significantly correlated with fewer depressive symptoms at T1 ($r = -.20$, $p < .01$), but not or only marginally so at T2 ($r = -.13$, $p = .08$). Moreover, a higher resulting rate did not predict residual change in depressive symptoms over the course of one month ($\beta = -.01$, $p = .91$). Our hypotheses thus were only partly confirmed.

Chronological age. Chronological age was not correlated with the overall resulting rate, irrespective of whether the entire sample was considered (r = .00, p = .99) or only participants younger than 23 years (r = -.02, p = .84). This mimics the findings of Study 2 when only considering the subsample of younger adults, and suggests that age-related differences only emerge when considering a larger proportion of the lifespan (e.g., comparing young and older adults).

Discussion

Results from Study 3 showed the validity of our measure for the goodness of a goal system when as many as 10 goals were considered for all four investigated goal-related constructs, for goal focus, and for the two indicators of well-being. Overall, the correlations of the resulting rate with goal-related constructs were larger compared to the studies that only sampled four or six goals. We found no, or only very weak, support concerning personality and chronological age within this group of young adults.

Summary of Correlative Results and Test of Utility of *R*

In order to compare the single correlational findings from the three different studies, we summarized them in Table 2 and computed average correlation coefficients both unweighted and weighted by the studies' sample sizes. The resulting correlation coefficients point to small- and medium-sized average effect sizes. The three highest correlation coefficients pertain to prospective engagement, process focus, and satisfaction with goal progress.

Finally, we wanted to compare the utility of our theoretically derived measure (see Equation 6) against the benchmark of simply averaging the goal-related appraisals (i.e., importance, expectation, conflict, and facilitation) by forming a mean composite value M of these measures without including multiplicative terms and without weighting any of the

components with $\lambda_j e_j$. The *M* value thus represents the simplest form of how the different goal-related indicators can be combined. Then, we repeated all analyses using this value. Table 3 summarizes the correlative results for all three studies. In most instances, the predictive value of *R* was superior to that of *M*. This was also true for the correlations with personality. Although they were not very large in size for *R* to begin with, they virtually disappeared for *M*.

In a next step, we recalculated the cross-lagged panel models for Study 1 to test (a) whether the *M* exhibits low retest reliability which could explain the low correlations in Table 3, and (b) whether *R* was superior to *M* in predicting the longitudinal relationships. Table 4 summarizes the results of these analyses. Retest reliability of *M* was satisfactory ($r_{tt} > .50$) in all models. Thus, low reliability cannot explain the lower correlations of *M* compared to *R* shown in Table 3. Moreover, most cross-lagged paths were smaller for *M* than for *R*, which again speaks for the superiority of the theoretically derived measure *R*.

We then repeated the analyses on goal disengagement of Study 1. Results of these analyses showed that *M* significantly differed for the primary, $t(260) = 2.20$, $p = .03$, and secondary, $t(259) = 3.52$, $p = .001$, goal in the family domain and the primary goal in the leisure domain, $t(257) = 3.38$, $p = .001$ between those who disengaged from the respective goal and those who did not. However, only for the secondary leisure goal the time × goal change interaction term became significant, $F(2, 450) = 9.01$, $p < .001$. Hence, although *M* predicted disengagement from some goals it did not increase as a consequence of this disengagement. Thus, although the results for *R* were also not without some deviations, *R* seemed to have produced the more consistent results compared to *M*.

Finally, we tested with data from Study 2 whether *M* was significantly correlated with the objective measures of physical activity and whether it significantly predicted change in the goal-

related measures over the course of the study. Neither turned out to be the case. Thus, again *R* proved superior to *M*, although both were derived from the very same data.

General Discussion

The present paper provides some supporting evidence for the usefulness of the resulting rate *R* as a theoretically well grounded, efficient, and useful measure for the goodness of a goal system comprising multiple goals. This measure has its theoretical roots in optimal foraging models used in ethology and extends psychological expectancy-value models by explicitly considering the facilitative and interfering relations that multiple goals may have among each other. It does so by weighting the capacity for facilitation and interference by the expectancy-value of the facilitative and interfering goals. Hence, goals that facilitate other goals with a high expectancy-value contribute more to the goodness of a goal system than goals that facilitate other goals with a low expectancy-value only; and goals that interfere with other goals with a low expectancy value only deteriorate the goodness of a goal system only weakly compared to goals that interfere with other goals with a high expectancy-value product. It is worth noting that the number of goals that contribute to this measure has an effect on the nominal size of the resulting rate *R*, but not necessarily on the average resulting rate per goal (see Figure 2). Thus, it seems possible to compare the different studies regardless of how many goals were assessed.

One of the strengths of the foraging approach to goal striving is that it considers the resources invested into goals in the search cost part of the disc equation. In our translation of the disc equation, these resources are implicitly represented in the conflict part. Under the assumption that resources are limited and finite, goals requiring many resources will be – all else being equal – more likely to be conflicting with other goals and vice versa. This implicit representation of required resources has two main advantages. First, it is not necessary to

introduce a specific unit or "currency" of the resources invested, but they are represented on the same scale as the resulting rate. This allows consideration of very different resources (temporal, physical, psychological, etc.) within the one model. Second, within our framework, all resources are not considered as equal, but they are weighted adequately by the expectancy-values of the goals. This weighting is reflected in the overall resulting rate *R* that represents the goodness of a goal system.

The empirical evidence of the three studies suggests that the goodness of a goal system is positively correlated with a number of goal-related variables, such as goal engagement or satisfaction with goal progress. Although the data were mostly based on self-reports, we also provided evidence from one study that included an objective measure of goal engagement. People whose goal systems are more optimal, according to our definition, are also more likely to engage in the pursuit of their goals and be satisfied during goal striving.

Furthermore, we found that people who focus more on the means relevant for goal striving are more likely to hold a more optimal goal system. Our explanation of this finding is that people who focus on the means of goal striving are better able to realize means-related interferences and facilitations, and thus are better able to adjust them so that interference is reduced and facilitation improved.

We also obtained some evidence that single goals, which are less than optimal as indicated by a low resulting rate, are more likely to be given up and replaced by goals that better fit into the goal system. This finding is in line with lifespan theoretical reasoning on selective optimization (Freund & Baltes, 2002). The resulting rate thus might be a useful indicator of single goals of which pursuit is maladaptive in the long run, be it because they only have little valence for the individual, because they are hardly attainable given internal resources and

external opportunities, because they deteriorate resources that are necessary for the pursuit of other goals, or because they show too little compatibility with other goals in the goal system. The goal-specific resulting rate introduced captures all of these four facets that make goals maladaptive.

Consistent with other research on age-related differences in intergoal conflict and facilitation (e.g., Riediger et al., 2007), we also found evidence that the goodness of a goal system is correlated with age, at least when a broad age range is investigated. However, the current studies were not designed to investigate age-related differences and, therefore, do not comprise a sufficiently age-heterogeneous sample that allows systematic testing of age-related changes across adulthood. The age-related difference emerged between age *groups* of young vs. older adults, which probably suggest that it might be the shift in developmental gains and losses that forces older people to optimize their goal systems in order to make more efficient use of their restricted resources (e.g., Heckhausen, 1999). An alternative explanation, which we can neither confirm nor exclude with the present data, is that older adults are more experienced in optimizing their goal system or that they profit from psychological gains in terms of income, status, integration, and stabilization of identity that allows them to have more optimized goal systems. As Study 2 did not include a middle-aged group, it is impossible to determine when the suggested process occurs and if it takes place gradually, representing a continuous adjustment to the aging process. Clearly, more research is needed to elucidate this fascinating phenomenon.

Results were mixed concerning associations of resulting rate *R* with personality and subjective well-being. Generally, the strength of associations was rather weak and inconsistent. Conscientiousness and openness to experience were most often associated with a high resulting rate *R*, but there were differences between the studies. It might be that some facet-level

constructs of personality, such as impulsivity (an aspect of neuroticism) or goal striving (an aspect of conscientiousness) would be more useful for predicting a high resulting rate *R*.[4] However, because a detailed assessment of personality was not the focus of any of the four studies and only brief measures of personality were used, we cannot test the associations in more detail. Furthermore, although it is likely that personality plays a role in forming a "good goal system," we cannot determine in which phase of setting and pursuing a goal the different personality traits might be most impactful.

Limitations

In this paper, we have presented cumulative evidence from three independent studies for the validity and usefulness of a measure for the goodness of goals and goal systems against the framework of the theory of optimal foraging. Despite its conceptual strengths, the paper also has some limitations. On a conceptual level, a central limitation is that our approach does not allow to discriminate whether intergoal facilitation is due to instrumental relations among goals or due to overlapping goal attainment strategies. Similarly, it does not allow determination of whether intergoal conflict is due to resource constraints or due to incompatible goal attainment strategies. The different reasons for intergoal facilitation and conflict might be differentially associated with personality or other goal-related constructs.

The individual studies have some conceptual limitations. In Study 1, we do not know if people disengaged from goals because they did not fit into their goal systems (as assumed here) or whether they disengaged from them because they already attained them. The way we asked people to generate their goals and our data supports the first interpretation, but the second one cannot be ruled out. In Study 2, the calculation of the resulting rate was based on one goal that was just taken up and three goals that were probably pursued for a longer period of time. Our

framework does not allow distinguishing between one new goal that might upset the existing goal relations and the overall goal system. In Study 3, a large number of goals and an even larger number of intergoal relations were assessed. Although this fact was helpful to demonstrate that the resulting rate also seems to function well when a large number of goals is considered, it also raises the question of whether participants might have not have filled out the questionnaire quite as reliably when having to rate such a large number of goal relations.

Future Directions

Applying optimal foraging theory to a system of multiple goals seems theoretically meaningful and empirically fruitful: This paper provides evidence for the efficiency, validity, and usefulness of the concept. Different extensions of this framework are possible: One we have already mentioned above is the integration of resources invested in goal striving, another one is the inclusion of a temporal perspective to better capture the dynamics of multiple goal striving over time. Moreover, it would be interesting to consider, both theoretically and empirically, the different stages of the action cycle that are likely to influence the relation between goals and, thereby, the resulting rate *R*. Goals are dynamic and so is the goal system.

Many goals cannot be pursued simultaneously, but need to be prioritized or pursued sequentially (Orehek & Vazeou-Nieuwenhuis, 2013). Optimal foraging theory provides mathematical models taking into account sequential foraging (Stephens et al., 2007) that might turn out to be useful for understanding sequential goal striving.

Another possible extension of the framework is its use for the prediction of goal engagement and goal disengagement using different models of optimal foraging, namely, those applied for animals who forage for prey and those who search for food in patches (Stephens et al., 2007). Foraging for prey requires a “decision” of when to initiate prey action, taking into

account resources, opportunities, success expectancies, and caloric value. This very much resembles human motivational decisions regarding when to initiate engagement with a certain goal. Searching for food in patches, in turn, requires a constant "monitoring of success" and a "decision" of when to leave an exploited patch for a better one, which strongly resemble human motivational decisions regarding when to give up no longer attainable goals and to re-engage with more promising ones (Tomasik & Silbereisen, 2012; Wrosch et al., 2003). Optimal foraging theory has developed different models for the two scenarios that await application in the domain of multiple goals.

In the present paper, we have considered the resulting rate of a goal in total without further analyzing its single components, such as the expectancy-value component of the focal goal, the conflict component, and the facilitation component originating from the focal goal. A more detailed analysis of the single components contributing the overall resulting rate *R* will help to identify the dimensions on which people optimize the goodness of their goal systems. People might attempt to reduce conflicts between goals, increase facilitative relations between them, reduce the expectancy-value of conflicting goals, increase the expectancy value of mutually facilitative goals, or combine these strategies in different ways. A person-centered approach using mixture models will probably be most useful to identify the different optimization strategies and to discern how they work and when they occur.

Finally, we anticipate new research grounds in the development and application of methods that can capture the single components of the resulting rate on a more implicit level of analysis. The successful application of optimal foraging theory not only in etiology, but also in the cognitive sciences or in research on personality, suggests that a conscious representation of the different parameters required in order to calculate the resulting rate is not essential. In

addition to the explicit measures used in the current studies, it would be interesting to include implicit measures of goal values and expectancies.

In conclusion, in this paper, we have applied mathematical models successfully used in ethology to the emerging field of multiple goal strivings in motivational psychology. In doing so, we have implicitly considered humans as *finivores* (lat. *finis* meaning "goal" and *vorare* meaning "to devour") or organisms that strive for goals and that derive their energy from goal-related consumptive behavior. If this metaphor is accurate, chances are good that optimal foraging theory will provide us with new inspiration and models for our research on human motivation and volition in the future.

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Footnotes

[1] Results based on data of Study 1 were published by Freund, Knecht, and Wiese (2014) and Knecht, Wiese, and Freund (2016). Freund et al. (2014) used measures of goal conflict and goal facilitation to predict psychosomatic symptoms assessed via self-report. They find that goal conflict is associated with more psychosomatic symptoms. No longitudinal data was used. Knecht et al. (2016) used measures of goal conflict and goal facilitation related to the leisure domain to predict subjective well-being over time. They find that goal conflict and goal facilitation is concurrently but not longitudinally related to subjective well-being. Standard mean composite scales of goal conflict and goal facilitation were used in both papers. Data of Study 2 were used by Riediger and Freund (2004), Riediger, Freund, and Baltes (2005) as well as Freund, Hennecke, and Riediger (2010). Riediger and Freund (2004) used measures of goal conflict and goal facilitation to predict subjective well-being and objective exercising. The authors find that goal conflict is associated with impairments of subjective well-being whereas goal facilitation predicts higher exercise adherence. Riediger et al. (2005) investigated age differences in goal conflict and goal facilitation and how these differences explain differences in goal pursuit. They find that older as compared to younger adults report both more goal facilitation and more goal engagement and that older adults higher engagement is partly mediated by higher levels of facilitation. In the latter two papers, goal conflict and goal facilitation were operationalized by standard mean composite scales. Freund et al. (2010) computed age differences in goal focus and investigated the association of goal focus with subjective goal evaluations, positive and negative affect, and goal achievement. They find that older adults report to have a stronger process focus as compared to younger adults and that for both age groups process focus predicts subjective goal evaluation, positive and negative affect,

and goal achievement. Data of Study 3 was used in a publication by Moberly and Dickinson (2016) who studied whether reasons of goal pursuit (i.e., intrinsic, identified, introjected, and external motivation) are associated with goal rumination. Perceived goal progress and importance were used as covariates but otherwise no variables analyzed in this paper were considered by the authors.

[2] In the few cases in which we had to remove single goals, we computed the resulting rate *R* based on the available goals and rescaled this variable as if it would represent six goals.

[3] The work was funded by the Economic and Social Research Council (ESRC).

[4] We are grateful to an anonymous reviewer for directing our attention to this possibility.

Table 1. Results of latent cross-lagged panel models.

	β				
Goal-related construct *G*	Auto-regression *R*	Auto-regression *G*	R_t predicting G_{t+1}	G_t predicting R_{t+1}	Model fit
Perceived goal progress	.69/.76 (.04/.04)	.46/.51 (.09/.10)	.22/.26 (.07/.08)	*.05/.05* (.05/.05)	$\chi^2(120) = 286.56$, $p < .01$; RMSEA = .070; CFI = .93
Satisfaction with goal progress	.69/.76 (.04/.04)	.60/.68 (.08/.08)	.12/.14 (.06/.07)	*.05/.05* (.05/.05)	$\chi^2(120) = 276.13$, $p < .01$; RMSEA = .069; CFI = .94
Perceived proximity of goal attainment	.69/.76 (.04/.04)	.68/.63 (.10/.08)	.17/.16 (.07/.06)	*.05/.05* (.05/.06)	$\chi^2(120) = 282.59$, $p < .01$; RMSEA = .070; CFI = .94
Prospective engagement	.50/.56 (.08/.08)	.47/.52 (.15/.16)	.25/.26 (.12/.13)	.29/.34 (.08/.10)	$\chi^2(120) = 272.50$, $p < .01$; RMSEA = .068; CFI = .94
Process focus	.67/.75 (.04/.04)	.67/.62 (.05/.06)	.09/.10 (.05/.05)	*.08/.07* (.05/.05)	$\chi^2(120) = 214.48$, $p < .01$; RMSEA = .053; CFI = .97
Outcome focus	.71/.79 (.03/.03)	.52/.55 (.05/.05)	*-.01/-.01* (.05/.05)	*-.05/-.05* (.03/.04)	$\chi^2(120) = 227.37$, $p < .01$; RMSEA = .057; CFI = .96

Note: All coefficients are standardized; Left-hand coefficients refer to paths between T1 and T2, right-hand coefficients refer to paths between T2 and T3; Respective standard errors of coefficients printed in brackets; Coefficients printed in italics are not significant at $p = .05$ (two-tailed) significance level.

Table 2. Summary of correlation coefficients.

	Average Effect								
	S1/T1	S1/T2	S1/T3	S2/T1	S2/T2	S3/T1	S3/T2	**raw**	**weighted**
Perceived goal progress	.27	.30	.37	.27	.36		.32	**.31**	**.31**
Satisfaction with goal progress	.26	.31	.32	.34	.39	.46		**.35**	**.34**
Perceived proximity of goal attainment	.32	.31	.35	.24	.35		.38	**.32**	**.32**
Prospective engagement	.47	.46	.44	.46	.41	.51		**.45**	**.45**
Process focus	.41	.32	.35			.36		**.36**	**.36**
Outcome focus	.02	.14	.04					**.07**	**.07**
Conscientiousness	.17	.07	.06	.18				**.12**	**.10**
Openness to new experience	.14	.13	.09	-.10				**.07**	**.08**
Neuroticism	-.08	-.12	-.07	-.18		-.12		**-.11**	**-.10**
Extraversion	.11	.11	.11	.03				**.09**	**.09**
Agreeableness	.11	.07	.14	.19				**.13**	**.11**

Satisfaction with life	.02	-.04	.03	.21				**.06**	**.04**
Mood[b]	.12	.07	.15	.22		.20	.13	**.15**	**.13**
Chronological age	.16	.16	.17	.39		.00		**.18**	**.16**
Sample size	269	237	233	145	145	210	194		

Note. All computations are based on Field (2001). Untransformed correlation coefficients have been used according to Hunter and Schmidt (1990). [a]First number indicates study, second number indicates measurement occasion; [b]Correlation coefficients recoded for depressive mood.

Table 3. Correlations between goal-related and other constructs with (a) mean-composite scale *M* of goal appraisals and (b) foraging function *R*.

	M	*R*
Perceived goal progress	.12	.27
	-.03	.30
	.06	.37
	.09	.27
	.13	.36
	N/A	N/A
	.17	.32
Satisfaction with goal progress	.01	.26
	-.06	.31
	.02	.32
	-.03	.34
	.06	.39
	.11	.46
	N/A	N/A
Perceived proximity of goal attainment	.04	.32
	.00	.31
	.09	.35
	.02	.24
	.08	.35
	N/A	N/A
	.27	.38
Prospective engagement	.24	.47
	.10	.46
	.21	.44
	.15	.46
	.16	.41

	.29	.51
	N/A	N/A
Process focus	.21	.41
	.13	.32
	.17	.35
	N/A	N/A
	N/A	N/A
	.12	.36
	N/A	N/A
Outcome focus	-.04	.02
	.14	.14
	.10	.04
	N/A	N/A
	N/A	N/A
	N/A	N/A
	N/A	N/A
Conscientiousness	.05	.17
	-.01	.18
	.09	.14
	.09	.18
	N/A	N/A
	N/A	N/A
	N/A	N/A
Openness to new experience	.05	.14
	.11	.22
	.08	.23
	-.01	-.10
	N/A	N/A
	N/A	N/A
	N/A	N/A
Neuroticism	.10	-.08

	.07	-.14
	.08	-.09
	-.08	-.17
	N/A	N/A
	.10	-.12
	N/A	N/A
Extraversion	.05	.11
	.12	.11
	.05	.11
	.07	.03
	N/A	N/A
	N/A	N/A
	N/A	N/A
Agreeableness	.02	.11
	.05	.09
	.09	.11
	-.10	.19
	N/A	N/A
	N/A	N/A
	N/A	N/A
Satisfaction with life	-.13	.02
	-.20	-.04
	-.11	.03
	-.06	.21
	N/A	N/A
	N/A	N/A
	N/A	N/A
Mood[b]	.17	.12
	.23	.07
	.12	.15
	-.08	.22

	N/A	N/A
	-.18	.20
	.-14	.13
Chronological age	.00	.16
	.05	.16
	.07	.17
	.16	.39
	N/A	N/A
	.00	.00
	N/A	N/A

Note: Study 1 (T1-T3) represented in lines 1-3; Study 2 (T1-T2) represented in lines 4-5; Study 3 (T1-T2) represented in lines 6-7

Table 4. Results of latent cross-lagged panel models with the mean-composite scale *M* of goal appraisals

	β				
Goal-related construct *G*	Auto-regression *M*	Auto-regression *G*	X_t predicting M_{t+1}	M_t predicting X_{t+1}	Model fit
Perceived goal progress	.65/.65	.55/.55	*.01/.01*	*.14/.14*	$\chi^2(45) = 79.35$, $p < .001$; RMSEA = .052; CFI = .95
	(.04/.04)	(.08/.08)	(.02/.02)	(.08/.08)	
Satisfaction with goal progress	.59/.68	.65/.74	*.00/.00*	*.05/.05*	$\chi^2(45) = 79.66$, $p < .001$; RMSEA = .053; CFI = .96
	(.03/.04)	(.07/.07)	(.04/.04)	(.04/.04)	
Perceived proximity of goal attainment	.58/.67	.73/.70	*.06/.06*	.10/.11	$\chi^2(45) = 75.47$, $p < .001$; RMSEA = .049; CFI = .96
	(.03/.03)	(.08/.07)	(.05/.05)	(.04/.05)	
Prospective engagement	.55/.65	.62/.68	*.02/.02*	.14/.16	$\chi^2(45) = 56.68$, $p < .001$; RMSEA = .031; CFI = .99
	(.04/.04)	(.10/.10)	(.05/.06)	(.05/.06)	
Process focus	.58/.67	.70/.76	.08/.10	*.07/.07*	$\chi^2(45) = 72.49$, $p < .001$; RMSEA = .047; CFI = .98
	(.03/.04)	(.05/.05)	(.04/.04)	(.04/.04)	
Outcome focus	.59/.69	.81/.81	.06/.06	*-.01/-.01*	$\chi^2(45) = 67.71$, $p < .001$; RMSEA = .043; CFI = .98
	(.03/.04)	(.04/.04)	(.03/.04)	(.04/.04)	

Note: All coefficients are standardized; Left-hand coefficients refer to paths between T1 and T2, right-hand coefficients refer to paths between T2 and T3; Coefficients printed in italics are not significant at $p = .05$ (two-tailed) significance level.

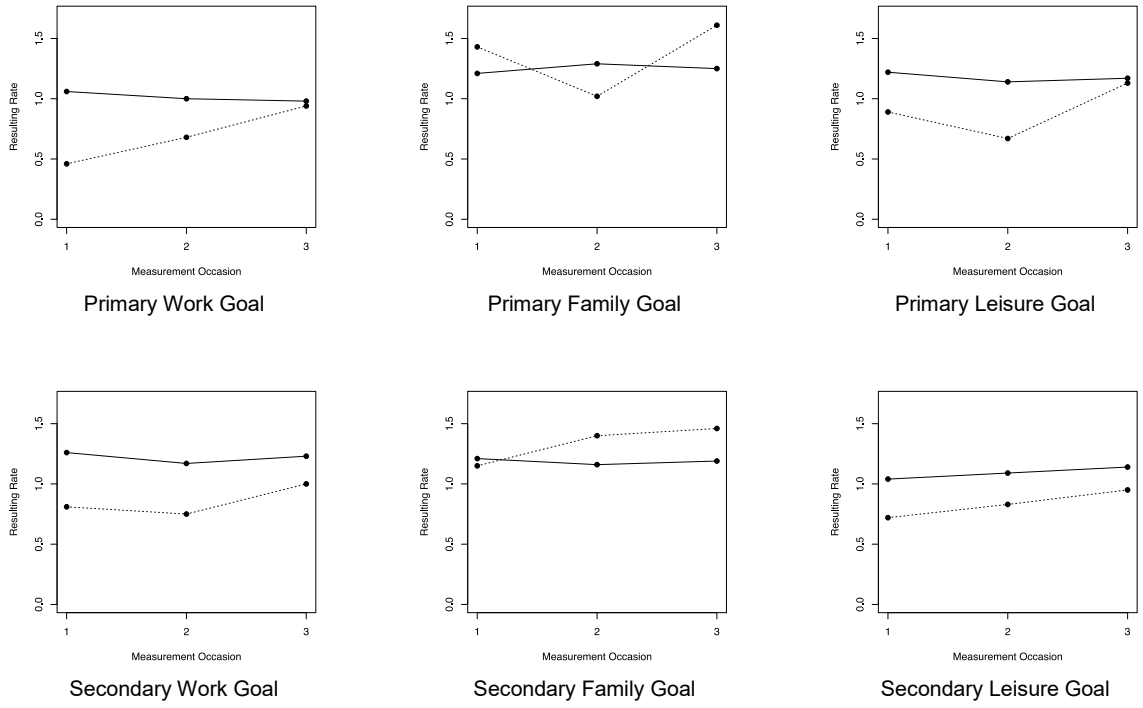

Figure 1. Trajectories of the goal-specific resulting rates R_i, depending on whether the goal was kept (solid line) or changed during the course of the study (dotted line).

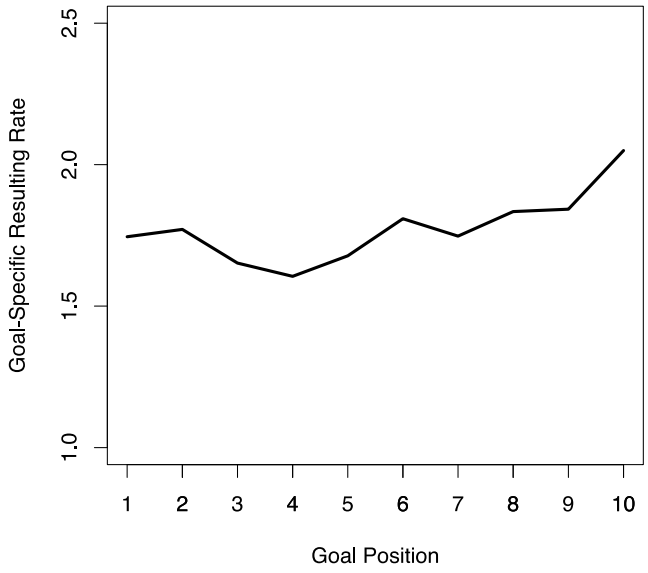

Figure 2. Goal-specific resulting rate R_i, depending on the goal's position of nomination *i* in the striving matrix.